Web-Based Analyses for Vehicle Engineering

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The preliminary design of an aerospace vehicle is a complex task, one that requires the collaborative effort of a group of engineers using many different engineering analysis software packages. During the early stages, the design goes through frequent changes from the original baseline, each change requiring parametric modifications to the computational models. Typically, no single person is proficient in the use of all of the required software, which means that the resident experts in each software package are tasked to spend considerable time making small, repetitive changes to the baseline models. In this project we seek to automate this process by building a Hypertext Markup Language (HTML) based user interface called WAVE (web-based analyses for vehicle engineering) which ties a subset of the capabilities of a set of engineering analysis tools into a straightforward uniform package that can be used by a design engineer who is not familiar with the details of the analysis software.

Using this method, the software experts first build parameterized models of the vehicle systems and environment, and then determine the best solution procedure for the given task. A customized interface is then built for the vehicle within WAVE that ties all of the analytical tools together. During the design process, the end user is presented with a subset of the capabilities of the original analysis software, consisting of only those parameters that have been chosen to vary during preliminary design. For example, in figure 1 the complexity of a computational fluid dynamics (CFD) code input deck with more than 100 input quantities has been reduced to an HTML form with eight parameters that define the free-stream conditions for the simulation. Similar reductions in complexity are made for each of the analysis packages. In this manner a single designer can quickly examine parametric variations about the baseline without the help of a team of software experts. Of course, expert help would still be required to go

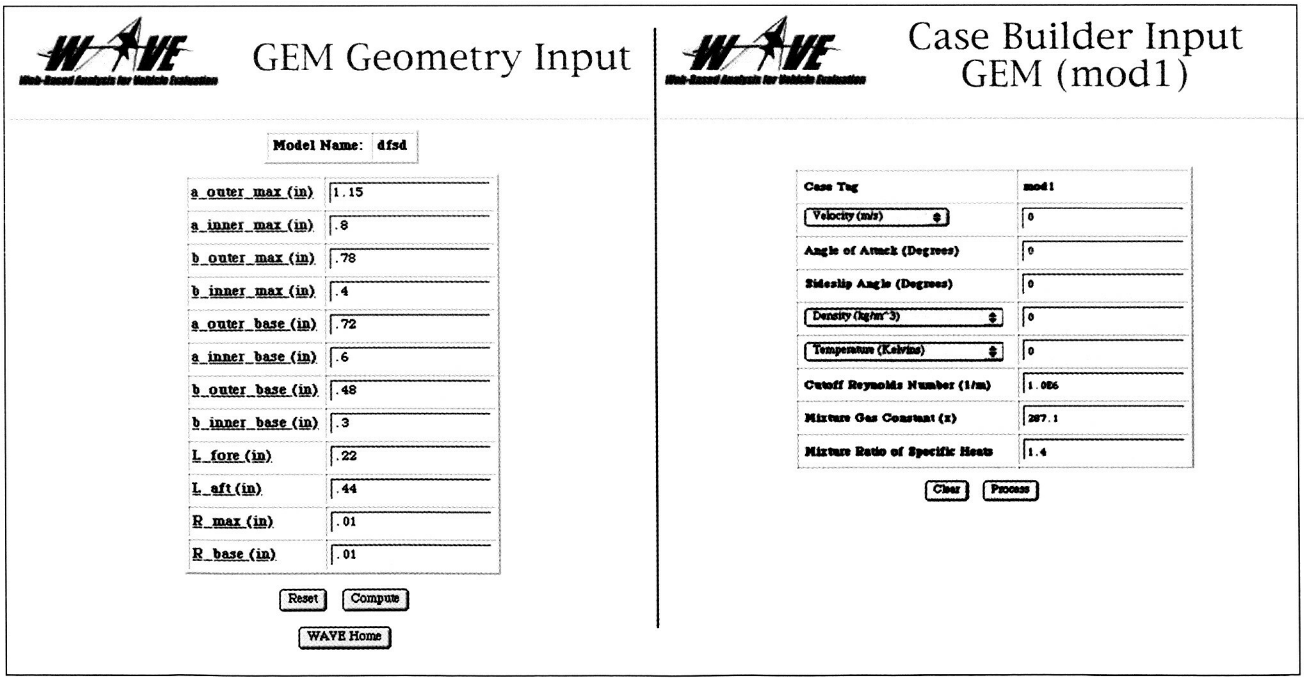

Fig. 1. Sample forms from WAVE interface.

beyond the boundaries of the original parametric models, but this would be an infrequent occurrence if the models were set up with sufficient flexibility.

In the test case shown here, we have automated the use of CFD for preliminary design by linking together a computer aided design (CAD) package (Pro-Engineer), grid generation software (Grid-Pro), a CFD code (GASP), and a post-processing tool (Tecplot). Sample HTML forms are shown in figure 1 for the CAD and CFD portions of the analysis. By stepping through each of the packages in turn the designer can make parametric changes to the baseline vehicle shape, generate appropriate volume grids, run CFD analyses, and view selected results, all from within a single web-based interface. At each step of the analysis, quality checking is performed, and questionable results are highlighted. Figure 2 shows the results of such a quality check on a volume grid. Cut-planes through the grid are shown, with questionable areas highlighted in yellow. The data resulting from this design process can then be moved offline for more detailed analysis, or archived for future use.

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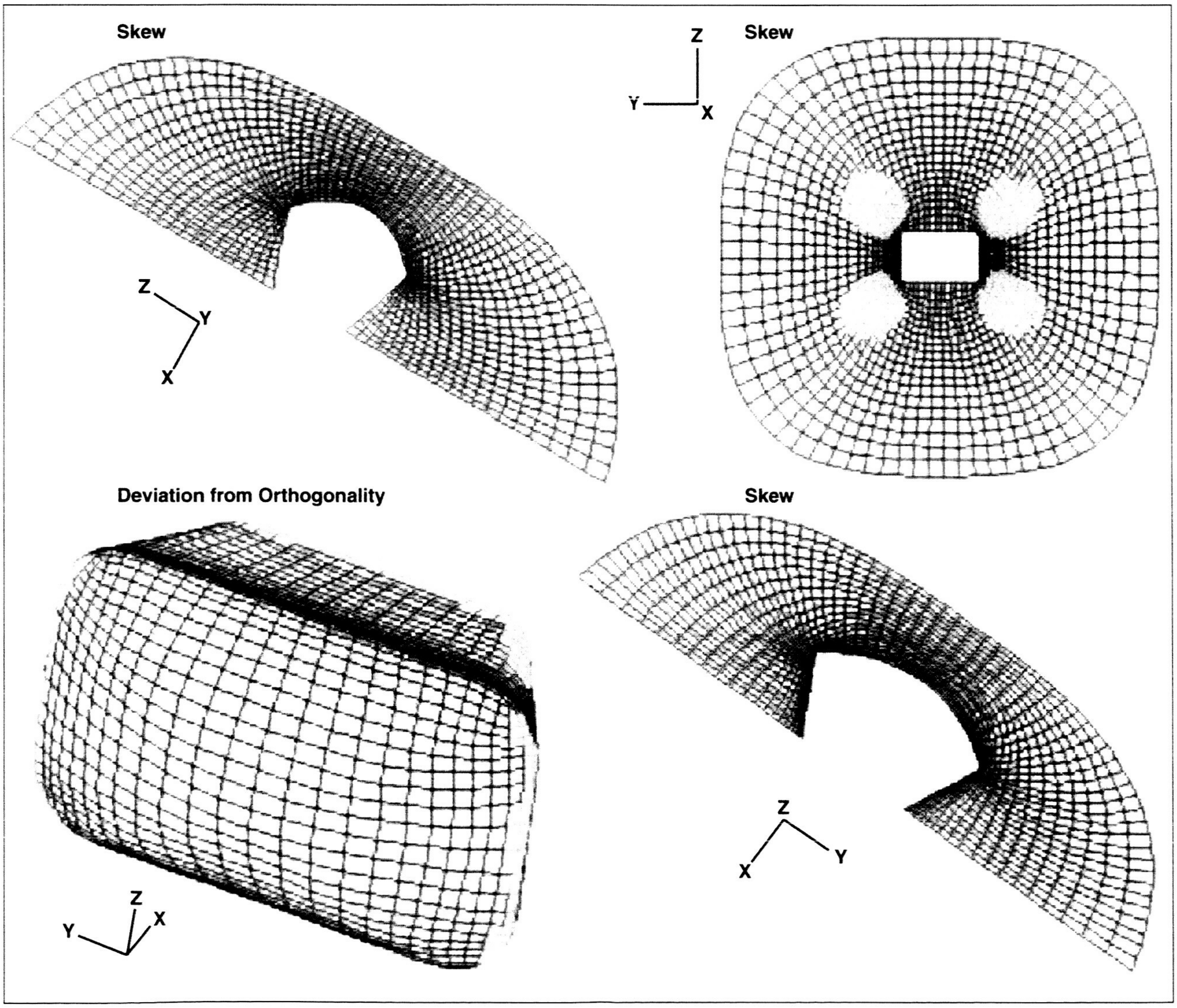

Fig. 2. Sample results from grid quality analysis.